

CLAIMS

What is claimed is:

1. A method for pseudo-planarization of an electromechanical device and for forming a durable metal contact on the electromechanical device comprising acts of:
 - depositing a dielectric layer having a thickness and an area on a substrate having a substrate area;
 - depositing a first photoresist film on the dielectric layer, patterned to leave electrode regions exposed;
 - etching through at least a portion of the thickness of a portion of the area of the dielectric layer at the electrode regions to form electrode spaces in the dielectric layer;
 - depositing a first conducting layer on the first photoresist film and dielectric layer such that a portion of the first conducting layer is formed in the electrode spaces in the dielectric layer;
 - removing the first photoresist film, thereby removing a portion of the first conducting layer residing on the first photoresist film;
 - depositing a sacrificial layer on the dielectric layer and the first conducting layer, the sacrificial layer having a thickness;
 - etching through the sacrificial layer to an electrode region in order to expose a portion of the first conducting layer at an electrode region to form an anchor site;
 - depositing an insulating first structure layer on the sacrificial layer and the anchor site, the insulating first structure layer having an area;
 - etching through the insulating first structure layer across at least a portion of the anchor site so that a portion of the first conducting layer is exposed, and etching through the insulating first structure layer and through a portion of the thickness of the sacrificial layer at a top electrode site so that a top electrode space

is defined through the insulating first structure layer, and into the sacrificial layer, proximate an electrode region;

depositing a second photoresist film on the insulating first structure layer, the second photoresist deposited in a pattern to form separation regions for electrically separating desired areas of the electromechanical device and for separating desired devices;

depositing a conducting second structure layer on the insulating first structure layer, the exposed portion of the first conducting layer, and in the top electrode space, the conducting second structure layer having an area;

removing the second photoresist film to eliminate unwanted portions of the conducting second structure layer in order to electrically separate desired areas of the electromechanical device and for separating desired devices;

depositing a insulating third structure layer on the electromechanical device, across the substrate area, the insulating third structure layer having an area; and

depositing a third photoresist film on the electromechanical device, across the substrate area, with the third photoresist film patterned to define desired device shapes by selective exposure; and

selectively etching through exposed portions of the insulating first structure layer and the insulating third structure layer to isolate an electromechanical device having a desired shape.

2. A method as set forth in Claim 1, further comprising an act of removing the sacrificial layer to release an actuating portion from a base portion, where the actuating portion includes portions of the insulating first structure layer, the conducting second structure layer, and the insulating third structure layer, and the base portion includes the substrate, the dielectric layer, and the electrode regions.
3. A method as set forth in Claim 2, further comprising an act of forming holes through portions of the actuating portion.

4. A pseudo-planarized electromechanical device with a durable metal contact formed by the method of Claim 1.
5. A pseudo-planarized electromechanical device with a durable metal contact formed by the method of Claim 2.
6. A pseudo-planarized electromechanical device with a durable metal contact formed by the method of Claim 3.
7. A method for pseudo-planarization of an electromechanical device comprising acts of:
 - depositing a dielectric layer having a thickness and an area on a substrate having a substrate area;
 - depositing a first photoresist film on the dielectric layer, patterned to leave electrode regions exposed;
 - etching through at least a portion of the thickness of a portion of the area of the dielectric layer at the electrode regions to form electrode spaces in the dielectric layer;
 - depositing a first conducting layer on the first photoresist film and dielectric layer such that a portion of the first conducting layer is formed in the electrode spaces in the dielectric layer;
 - removing the first photoresist film, thereby removing a portion of the first conducting layer residing on the first photoresist film;
 - depositing a sacrificial layer on the dielectric layer and the first conducting layer, the sacrificial layer having a thickness;
 - etching through the sacrificial layer to form a dimple portion of a top electrode space proximate an electrode region;
 - etching through the sacrificial layer to an electrode region in order to expose a portion of the first conducting layer at an electrode region to form an anchor site;

depositing a dimple metal layer in the dimple portion to form a dimple portion;

depositing an insulating first structure layer on the sacrificial layer and the anchor site, the insulating first structure layer having an area;

etching through the insulating first structure layer across at least a portion of the anchor site so that a portion of the first conducting layer is exposed, and etching through the insulating first structure layer at the top electrode space so that the top electrode space is defined through the insulating first structure layer to the dimple portion;

depositing a second photoresist film on the insulating first structure layer, the second photoresist deposited in a pattern to form separation regions for electrically separating desired areas of the electromechanical device and for separating desired devices;

depositing a conducting second structure layer on the insulating first structure layer, the exposed portion of the first conducting layer, and in the top electrode space, the conducting second structure layer having an area;

removing the second photoresist film to eliminate unwanted portions of the conducting second structure layer in order to electrically separate desired areas of the electromechanical device and for separating desired devices;

depositing a insulating third structure layer on the electromechanical device, across the substrate area, the insulating third structure layer having an area;

depositing a third photoresist film on the electromechanical device, across the substrate area, with the third photoresist film patterned to define desired device shapes by selective exposure; and

selectively etching through exposed portions of the insulating first structure layer and the insulating third structure layer to isolate an electromechanical device having a desired shape.

8. A method as set forth in Claim 37, further comprising an act of removing the sacrificial layer to release an actuating portion from a base portion, where the

actuating portion includes portions of the insulating first structure layer, the conducting second structure layer, and the insulating third structure layer, and the base portion includes the substrate, the dielectric layer, and the electrode regions.

9. A method as set forth in Claim 8, further comprising an act of forming holes through portions of the actuating portion.
10. A pseudo-planarized electromechanical device formed by the method of Claim 7.
11. A pseudo-planarized electromechanical device formed by the method of Claim 8.
12. A pseudo-planarized electromechanical device formed by the method of Claim 9.
13. A method for forming an electromechanical device having a durable metal contact comprising acts of:
 - providing a substrate having a substrate area and having a dielectric layer with a plurality of conductors formed therein as a first conducting layer;
 - depositing a sacrificial layer on the dielectric layer and the first conducting layer, the sacrificial layer having a thickness;
 - removing a portion of the sacrificial layer to form a dimple portion of a top electrode space proximate an electrode region;
 - depositing a dimple metal layer in the dimple portion to form a dimple;
 - depositing an insulating first structure layer on the sacrificial layer, the insulating first structure layer having an area;
 - removing a portion of the insulating first structure layer at the top electrode space so that the top electrode space is defined through the insulating first structure layer to the dimple portion, where the dimple metal layer acts as to stop the removing process;
 - depositing a first photoresist film on the insulating first structure layer, the first photoresist deposited in a pattern to form separation regions for electrically

separating desired areas of the electromechanical device and for separating desired devices;

depositing a conducting second structure layer on the insulating first structure layer, on exposed portions of the first conducting layer, and in the top electrode space, the conducting second structure layer having an area;

removing the second photoresist film to eliminate unwanted portions of the conducting second structure layer in order to electrically separate desired areas of the electromechanical device and for separating desired devices;

depositing a insulating third structure layer on the electromechanical device, across the substrate area, the insulating third structure layer having an area;

depositing a second photoresist film on the electromechanical device, across the substrate area, with the second photoresist film patterned to define desired device shapes by selective exposure; and

selectively etching through exposed portions of the insulating first structure layer and the insulating third structure layer to isolate an electromechanical device having a desired shape.

14. A method as set forth in Claim 13, further comprising an act of removing the sacrificial layer to release an actuating portion from a base portion, where the actuating portion includes portions of the insulating first structure layer, the conducting second structure layer, and the insulating third structure layer, and the base portion includes the substrate, the dielectric layer, and the electrode regions.
15. A method as set forth in Claim 14, further comprising an act of forming holes through portions of the actuating portion.
16. An electromechanical device having a durable metal contact formed by the method of Claim 13.

17. An electromechanical device having a durable metal contact formed by the method of Claim 14.
18. An electromechanical device having a durable metal contact formed by the method of Claim 15.
19. A head electrode region of a beam for a an electromechanical device comprising:
 - a first insulating layer having electrode region edges; and
 - a head electrode, where the head electrode comprises a locking portion, with the locking portion surrounding the electrode region edges of the first insulating layer such that the head electrode is held fixed relative to the first insulating layer.
20. A head electrode region of a beam for a an electromechanical device as set forth in Claim 19, wherein the head electrode has a top region residing above the first insulating layer and a contact region residing below the first insulator, the head electrode region further comprising a second insulating layer formed to cover at least a portion of the top region of the head electrode.
21. A planarized substrate structure for an electromechanical device comprising:
 - a substrate layer;
 - a dielectric layer formed on the substrate layer, the dielectric layer formed with conductor spaces therein, the dielectric layer further including a dielectric top surface; and
 - a conducting layer formed as a set of conductors in the conductor spaces of the dielectric layer, the conducting layer having a conducting layer top surface, and where the dielectric top surface and the conducting layer top surface are formed in a substantially co-planar fashion to provide a planarized substrate structure.
22. A method for forming a cantilever beam comprising acts of:

forming a metal dimple in a sacrificial oxide;
depositing a lower nitride structure over the sacrificial oxide and the metal dimple;
etching a hole through the lower nitride structure into the metal dimple;
evaporating Au above the metal dimple into the hole;
removing a portion of the lower nitride structure in a base region to form a metal anchor;
depositing a metal layer to form a DC actuation pad; and
depositing an upper nitride layer to complete the beam formation.

23. A method for forming a cantilever beam as set forth in Claim 22, wherein:
the act of forming a metal dimple is a photolithographic lift-off process
the act of evaporating of Au is performed by a process selected from a group consisting of lift-off process or plating process; and
the act of depositing a metal layer to form a DC actuation pad is performed by a process selected from a group consisting of a lift-off process and a plating process.

24. A cantilever beam formed by the method of Claim 22.